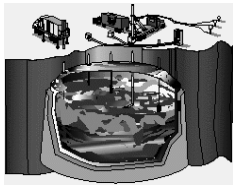
An Advanced, Open-Path Atmospheric Pollution Monitor for Large Areas



Developer: Westinghouse Science and Technology
Contract Number: DE-AR21-95MC32087
Crosscutting Area: CMST

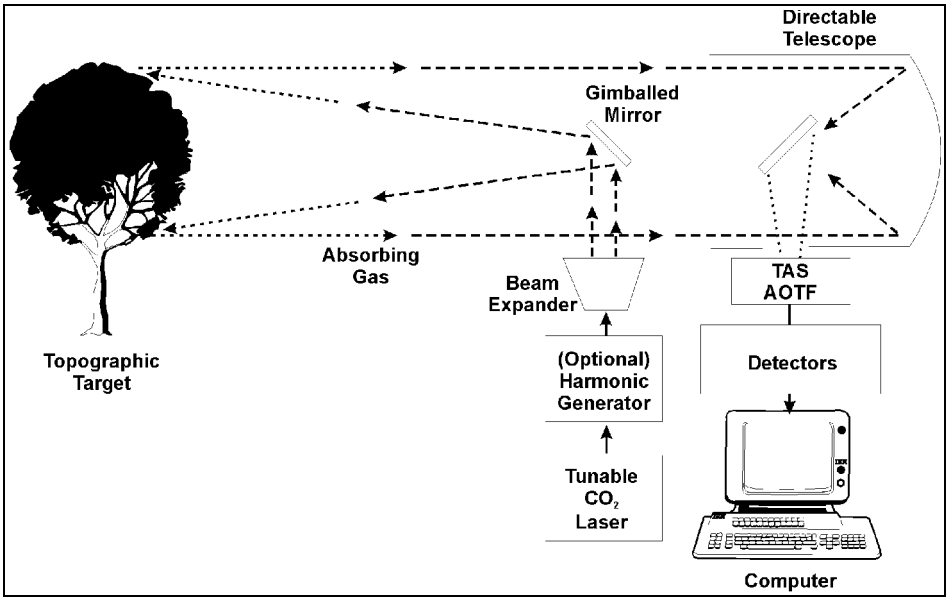
Tanks FOCUS AREA

Problem:

Large amounts of toxic waste materials have been generated in manufacturing fuel for nuclear reactors. These materials are stored in tanks buried over large areas at DOE sites. Flammable and hazardous gases can occur in dangerous and potentially explosive concentrations in the tank headspace and are vented from the tanks when the pressure exceeds a preset value. Real-time monitoring of the atmosphere above the tanks with automatic alarming is needed to prevent exposing workers to potentially unsafe conditions when this venting occurs.

Solution:

Measure concentrations of atmospheric constituents by combining 1) CO_2 laser to measure absorption spectra in the 9-11 m region and to determine the distance over which the measurements are made and 2) an acousto-optic tunable filter (AOTF) to measure the thermal emission spectra in the 2-14 m region.



Benefits:

- Rapid open-path monitoring of large areas, with 4 km radius, for toxic and hazardous gases
- Reduced monitoring costs for large areas
- Reduced personnel exposure to harmful gases
- Rapid unplanned measurements of fugitive releases anywhere within the monitor's operating radius
- Easy setup and use, e.g., does not use retroreflectors, all equipment is at one location, and computer control can provide unattended operation
- Easy movement and use in any location, e.g., mountains, deserts, buildings, etc.

Technology:

This project includes the design, development, and testing of an atmospheric pollution monitor which can measure concentrations

of hazardous gases over ranges as long as 4 km. The basic concept is shown in the figure. A pulsed CO_2 laser provides ~60 lines which, due to the laser lines being very narrow, provides high spectral selectivity in the 9-11 m region which is within the "fingerprint" region of 8-14 m where most large molecules have unique spectral absorption signatures. An optional harmonic generator doubles the laser frequency for detecting a few molecules which have absorption spectra around 5 m but not in the 9-11 m region.

The laser beam is reflected from a topological object, e.g., a tree or building, and its time of flight measured to determine the range to the object. The range is needed to determine the average concentration of any gas along the optical path. An AOTF measures the thermal emission spectra from 2 to 14 m, thereby complementing the absorption spectra from the CO_2 laser. Concentrations are determined from the emission intensity and laser-determined range.

The monitor will be (1) fully self-contained, except for electrical power; (2) pointable in any direction; (3) self-calibrating via a calibration gas cell; and (4) either technician operated or automatically operated. A dedicated processor will identify hazardous gases from their absorption and/or emission spectra, and determine their concentration from the measured optical intensity and range. An adjustable audio alarm will sound when preset toxicity levels are exceeded. All data, including the pointing direction and range, will be recorded, as well as the calculated concentrations for detected species.

Contacts:

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DOE's Morgantown Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

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